NASA STTR 2012 Phase I Solicitation

T8 Science Instruments, Observatories and Sensor Systems

Science Instruments, Observatories, and Sensor Systems addresses technologies that are primarily of interest for missions sponsored by NASA's Science Mission Directorate and are primarily relevant to space research in Earth science, heliophysics, planetary science, and astrophysics. This topic consists of three Level 2 technology subareas: remote sensing instruments/sensors, observatories, and in situ instruments/sensors.

Subtopics

T8.01 Innovative Subsystems for Small Satellite Applications

Lead Center: GSFC

Participating Center(s): ARC

This STTR solicitation is to help provide advanced technologies for satellites with masses less than approximately 20 kg and volumes less than approximately 10,000 cm3. Components or subsystems are sought that demonstrate a capability that is applicable to orbital missions to 800 km and mission durations up to 2 years. New approaches, subsystems, and components are sought that will:

- Substantially reduce the resources (cost, mass, volume, or power).
- Provide satellite bus capabilities that increase the capabilities of very small satellites while meeting the significant constraints imposed by the very limited size and mass of the observatory.

Components and subsystems are required that consider the severe mass, volume, and power constraints imposed by very small spacecraft.

T8.02 Technologies for Planetary Compositional Analysis and Mapping

Lead Center: JPL

This subtopic addresses the need for low mass, low power technologies that support orbital and in situ compositional analysis and mapping. The focus is on developing and demonstrating technologies that can be proposed to future planetary missions. Technologies that can increase instrument resolution, precision and sensitivity, or achieve new & innovative scientific measurements, are solicited. Two areas are of particular interest: micro-scale analysis and mapping of the mineralogy, organic compounds, chemistry and elemental composition of planetary materials, related to rock fabrics and textures; and remote mapping of geologic outcrops and features. Such technologies are particularly relevant for future landed missions to the Moon, comets, asteroids, Mars, Europa, Titan, and other planetary bodies. For example missions, see (http://science.hq.nasa.gov/missions). For details of the specific requirements see the National Research Council's, Vision and Voyages for Planetary Science in the Decade 2013-2022 (http://solarsystem.nasa.gov/2013decadal/).

Possible areas of interest include:

- Improved sources such as lasers, LEDs, X-ray tubes, etc. for imaging and spectroscopy instruments (including Laser Induced Breakdown Spectroscopy, Raman Spectroscopy, Deep UV Raman and Fluorescence spectroscopy, Hyperspectral Imaging Spectroscopy, and X-ray Fluorescence Spectroscopy).
- Improved detectors for imaging and spectroscopy instruments (e.g., flight-compatible iCCDS and other time-gated detectors that provide gain, robot arm compatible PMT arrays and other detectors requiring high voltage operation, detectors with improved UV and near-to-mid IR performance, near-to-mid IR detectors with reduced cooling requirements).
- Technologies for 1-D and 2-D raster scanning from a robot arm.
- Novel approaches that could help enable in situ organic compound analysis from a robot arm (e.g., ultra-miniaturized Matrix Assisted Laser Desorption-Ionization Mass Spectrometry).
- "Smart software" for evaluating imaging spectroscopy data sets in real-time on a planetary surface to guide rover targeting, sample selection (for missions involving sample return), and science optimization of data returned to Earth.
- Other technologies and approaches (e.g., improved cooling methods) that could lead to lower mass, lower power, and/or improved science return from instruments used to study the elemental, chemical, and mineralogical composition of planetary materials.

Projects selected under this subtopic should address at least one of the above areas of interest. Multiple-area proposals are encouraged. Proposers should specifically address:

- The suitability of the technology for flight applications, e.g., mass, power, compatibility with expected shock and vibration loads, radiation environment, interplanetary vacuum, etc.
- Advantages of the proposed technology compared to the competition.
- Relevance of the technology to NASA's planetary exploration science goals.

T8.03 Science Instruments for Small Missions (SISM)

Lead Center: ARC

Advancements in supporting spacecraft technologies are making small spacecraft more and more capable. Features such as extensive computing power, attitude determination and control systems, and even propulsion are allowing mission designers to consider small and very small spacecraft to perform operational and scientific investigations. However, one area that is lagging is the miniaturization of instrument systems that would be compatible with this new class of small spacecraft. Until science instruments can be downsized in order for them to be accommodated on small spacecraft, the utility of cubesats, nanosats, and mini-spacecraft platforms will be limited.

To stimulate and create scientific instrument technologies that are compatible with small spacecraft, this subtopic seeks to identify, develop, and prepare for flight demonstration, scientific instruments compatible with one or more of the small spacecraft platforms described at the end of this solicitation. Science applications may be in Astrophysics, Earth Science, Heliophysics, Planaetary Science, or Astrobiology.

Examples for proposals sought include, but are not limited to:

Astrophysics:

- *Need* - Ability to view diffuse / dispersed / low-intensity astrophysical phenomena requiring zero light background without high spatial resolution; good for full-sky mapping applications.
- *Instrument* - Multiband / hyperspectral imaging compact telescope
- Measurement **-** ERE emission from bright ionized (HII) regions, e.g., Orion Bar ionization edge, and correlation of ERE and PAH emissions from any orbit with at lest multi-month lifetime.
- *Impact* - Understanding of astrophysical phenomena, esp. those relevant to carbon sources. Such measurement will demonstrate the science capability on small spacecraft.

Earth Science:

- *Need* - Mapping terrestrial phenomena with multiple low-cost imagers for short-revisit period capability.
- *Instrument* - Hyperspectral Earth imager (including constellations of multiple imagers)
- *Measurement* - Ocean color due to algal blooms and other natural phenomena, or anthropogenic impact due to deforestation, CO_2 emissions, etc. Such measurements may require spectral mapping of large areas with short re-map period. Demonstration may be from a sun synchronous low earth orbit.
- *Impact* - Better tracking / understanding of algal blooms sources, CO_2 sources, etc. Such measurement will

demonstrate science capability on small spacecraft.

Earth Science:

- *Need* - Long-path atmospheric analysis (using sun as light source)
- *Instrument* - Compact (FT)IR spectrometer w/ telescope
- *Measurement* - Assess highly dilute inorganics or organics in upper atmosphere due to pollution or meteoritic infall, from Low Earth Orbit.
- *Impact* - Improved understanding of pollutant dynamic mobility/ degradation and/or cosmic organic sources. Such measurement will demonstrate science capability on small spacecraft.

Planetary Science:

- *Need* -
  - Evaluating the reactivity / habitability of extraterrestrial surfaces.
  - On orbit analysis of materials exposed to the space environment.
- *Instrument* - Compact XPS (X-ray photoelectron spectrometer) for surface chemistry analysis - moon, Mars, NEOs, beyond.
- *Measurement* - Characterization of regolith chemical reactivity: quantify reactive inorganic ions & radicals incl. oxyhalides, peroxides, superoxides, odd-O/odd-H species; regolith organic alteration products. Subsurface measurement of supports for and threats to life: energy sources; possible toxic & reactive compounds; soluble anions/cations& dissolved gases.
- *Impact* - Buy down of long term risk. Demonstrating on-orbit material analysis capability, for technology that will be deployed on landers or rovers, will lead to better understanding of surface conditions that impact survival of organics, biomarkers, and life.

Planetary Science:

- *Need* -
  - Investigating the Reactivity / habitability / evolution of extraterrestrial surfaces.
  - On orbit analysis of materials exposed to the space environment.
- *Instrument* - Compact SIMS (secondary ion mass spectrometer) or LDMS (laser desorption mass spec) for surface mass & chemistry analysis - moon, Mars, NEOs, beyond.
- *Measurement* - Characterization of regolith chemical reactivity: quantify reactive inorganic ions & radicals incl. oxyhalides, peroxides, superoxides, odd-O/odd-H species; regolith organic alteration products. Subsurface measurement of supports for and threats to life: energy sources; possible toxic & reactive compounds; soluble anions/cations& dissolved gases.

- *Impact* - Buy down of long term risk. Demonstrating on-orbit material analysis capability, for technology that will be deployed on landers or rovers, will lead to better understanding of surface conditions that impact survival of organics, biomarkers, and life.

Astrobiology:

- *Need* - Evaluate rates and nature of mutations caused by the space environment.
- *Instrument* - Miniaturized DNA sequencer to study mutations
- *Measurement* - Cultures of cells or small organisms supported in space radiation environment for months: evaluate genetic profile after 1000's of generations Location would be High Earth Orbit, geo-syn, or various libration points.
- *Impact* - Understand how mutation can play a role in rapid evolution in response to radiation stressors. Miniaturization and demonstration on a small spacecraft mission may eventually lead to a compact sequencer for personalized medicine.

Proposals are sought that significantly advance state of the art for scientific measurements. Proposals for science instruments that represent only incremental improvements in the state-of-the-art capabilities, or are of interest to relatively few users are not appropriate for this solicitation. Proposed concepts should show a relevance to external customers or stakeholders needs.

Proposer shall describe the proposed design, development, analysis, testing and evaluation needed for the technology; and outline a concept of operations for demonstration of the technology on a small mission platform. How the proposed technology is differentiated from currently available technologies must be clearly communicated.

Phase I contracts will be expected to demonstrate feasibility, and Phase II contracts will be expected to fabricate and complete ground testing on an actual instrument/test article for potential demonstration on a small mission.

Small Spacecraft Platforms

Cubesats - Cubesats are usually 10 x 10 x 10 cm (for a 1U) or 10 x 10 x 30 cm (for a 3U) nanosatellites. Other sizes are also in development, such as a 6U. Cubesats are typically launched as auxiliary spacecraft. Multiple cubesats may also be launched simultaneously in order to create constellations and other useful space architectures.

Specifications and standards for cubesats may be found at (http://www.cubesat.org/).

University Nanosats - University Nanosats are typically 50 x 50 x 60 cm and weigh less than 50 kg. They are also auxiliary spacecraft launched with other spacecraft on rideshare missions, typically using 15" or 8" Lightband deployment systems (see http://www.planetarysystemscorp.com/ for more info on Lightband and Planetary Systems, Corp.).

The Air Force Research Lab has sponsored the development of these spacecraft via the University Nanosat Program (see http://prs.afrl.kirtland.af.mil/UNP/).

Technology Demonstration Spacecraft - A larger spacecraft platform for the demonstration of a number of instrument payloads was illustrated by the recent NASA/MSFC FASTSAT mission. FASTSAT is an ESPA-class spacecraft, deployed via a 15" Lightbanddeployer, and is designed to accommodate a number of independent instrument systems. FASTSAT provides basic power, data/communications, and thermal management support for these payloads as part of an integrated space flight demonstration mission.